Saskatchewan Agriculture and Food

Potassium Fertilization in Crop Production

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The need for potassium

Potassium (K) is one of 17 nutrients that are essential for plant growth. Like nitrogen (N) and phosphorus, it is a macronutrient because plants require large amounts of K. Depending on the plant, the K requirement can be as high as the N requirement. The following table shows the amount of potassium used by selected crops. Unlike most nutrients, most K is retained in the straw, or stems of crops. This means that relatively little K is removed each year with seed harvest, but large amounts of K are removed with harvest of straw, and forage or green feed crops.

Table 1. K_2O* (lb./ac) taken up by various crops.

Crop	Yield bu./ac.	Grain lb. K_2O/ac.	Straw lb. K_2O/ac.	Total lb. K_2O/ac.
Wheat	40	16 - 19	49 - 61	65 - 80
Barley	80	23 - 28	73 - 89	96 - 117
Canola	35	16 - 20	57 - 69	73 - 89
Flax	24	13 - 16	26 - 32	39 - 48
Pea	50	32 - 39	91 - 111	123 - 150
Lentil	30	29 - 36	40 - 48	69 - 84
Alfalfa	2 tons	-	-	108 - 132

*The K content of fertilizers is expressed in the oxide form as K_2O equivalent even though no K_2O as such occurs in the fertilizer. The K_2O designation is a standard expression of relative K content. Potash fertilizer (KCl) actually contains 51 per cent K, 47 per cent Cl and two per cent iron and clays. To convert from K to K_2O, multiply by 1.2, to convert K_2O to K multiply by 0.83.

Plants remove the ionic form of potassium (K^+) from the soil.

Potassium (K) plays more roles in a plant than any other nutrient. Potassium does not become a direct part of the plant structure, but acts to regulate water balances, nutrient and sugar movement in plant tissue, plus drives starch and protein synthesis and legume nitrogen fixation.

The varied functions of potassium lead to a wide array of symptoms when deficient, such as:

- Slow growth

- Poorly developed root systems, weak stems and frequent lodging due to weak cell wall structure
- Lower yields
- Produce smaller, shrivelled seed
- More susceptible to disease and to winterkill
- Poor water use efficiency
- Poor N uptake

Potassium is highly mobile within the plant. This implies the crop may move K from old leaves to new plant parts, and a plant may be able to partly overcome an early potassium deficiency if the roots encounter better soil or fertilizer potassium supplies during the growing season. K deficiency symptoms, therefore, appear first on older leaves. As deficiency increases, symptoms progress to the upper parts of the plant. Symptoms include browning or scorching on the leaf edges of cereal crops, and in spots across leaves of broadleaf crops.

The need for K in Saskatchewan

Total K content of Saskatchewan soils ranges from 100 to 50,000 lb./ac., depending on the parent material that formed the soil. However, usually less than two per cent of the total K is plant available.

It is estimated that only approximately one million acres are K deficient. The most severe deficiencies occur in the north and northeast, but K deficiency is possible in localized areas in all regions of the province (see map.) Sandy loam to loamy sand soils and peat soils are often K deficient. Fields where straw is continually removed should be monitored for K deficiencies. Forages harvested for hay also have high K removal rates, so forage fields need to be monitored.

Potassium deficiency can be complex. Soil tests can show adequate levels of available K, but crops will still respond to fertilization. Many factors interfere with crop uptake of K, including:

- Free lime in the rooting zone
- Poor drainage
- Cool soil temperatures
- Soil compaction
- Shallow rooting

K fertilizers

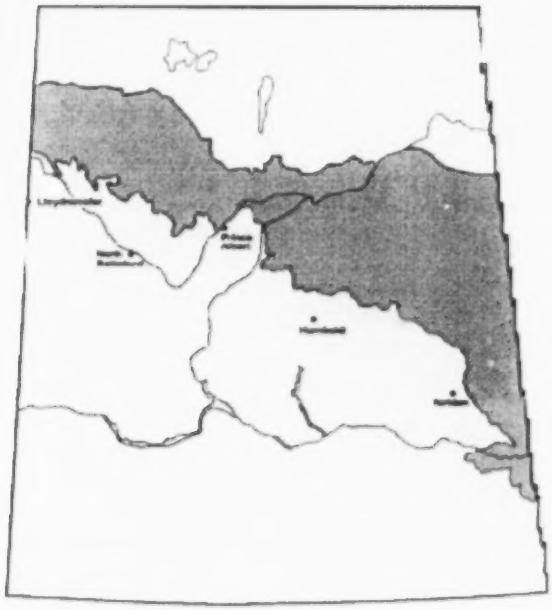

Figure 1. Potential K deficiency and response in Saskatchewan.

Soils in these areas may be K deficient, especially if sandy.
Soil test to check for potential K response.

Potassium chloride (KCl), called muriate of potash or just potash, is the least expensive and most common form of K fertilizer. It contains 60 to 62 per cent K_2O, and can be pink or white in colour. Each product is equally available to the growing plant. Another source of K is potassium sulphate (K_2SO_4). However, the sulphate form is often used in vegetable production and other crops that are sensitive to Cl additions.

Applied K fertilizer is readily dissolved by soil moisture, permitting ready absorption by plants.

K is relatively mobile in sandy soil. In heavier textured soils, K is much less mobile due to slower water movement through the soil profile and adsorption of K on the soil cation exchange. In this case, most movement is by diffusion through the water films surrounding clay particles. Dry and cool soil conditions slow K diffusion, and plants can experience a weather-induced K deficiency, unless high soil K levels and/or substantial root systems are available.

Flooded soils, poor fertility, excessive compaction of surface soil, an impermeable sub-surface soil layer, and other factors that restrict root growth, increase the reliance on diffusion, and thus inhibit K uptake by the plant.

Application of Potash (KCl)

The application method depends on soil and crop conditions, as well as seeding equipment design. Application rates often depend on soil test recommendations to correct the K deficiency and application method.

For lower rates, placement with the seed is often the best application method, since it is readily available to the plant. However, oilseed, pulse and forage crops have a fairly low tolerance to seed placed K, and seedling damage from the salt-effect can result from over-application.

Higher levels of clay, organic matter and soil moisture increase the amount of fertilizer that can safely be applied with the seed.

Similarly, if more of the seedbed is utilized, more fertilizer can be applied.

For example, if the seeding implement has a 10 inch spacing that spreads the fertilizer over two in., the Seedbed Utilization (SBU) will be (2/10 x 100 =) 20 per cent. A one in. spread on 10 in. spacing will have a SBU of (1/10 x 100 =) 10 per cent. The higher the SBU, the more fertilizer that can safely be applied with the seed provided seedbed moisture is good to excellent.

Where potassium fertilizer (K_2O) is added with the seed, use the phosphorus guidelines. The total of phosphate (P_2O_5) plus potassium (K_2O) should not exceed the maximum safe rate of seed placed phosphate (P_2O_5). This applies under good to excellent moisture conditions. See the Phosphorus fact sheet for a complete table of crops and safe rates of seed-placed P and K.

Side-banding K as little as one in. below and one in. to the side of the seed or mid row banding, effectively separates seed and fertilizer to allow greater application rates.

Banding K in a separate operation with other fertilizers will also allow greater application rates.

Broadcasting and incorporating K prior to seeding can be an effective method of application, especially for vegetable, forage and other crops or soils that require high application rates. However, if K is broadcast and incorporated rather than banded, the application rate may need to be doubled, and if top-dressed it may need to be tripled, depending on soil conditions. The differences between broadcasting and banding decrease as soil test K levels increase. Place at least 10 to 15 lb. K_2O/ac. with the seed on very K deficient soils.

Response to K fertilizer

Saskatchewan researchers have studied K fertilization in field trials since 1949. Soils in the Gray and Black soil zones testing less than 210 lb./ac. of available K in the top six in. of soil have been most responsive to K fertilization. However, isolated responses have occurred in other soil zones at higher soil test levels.

In addition to yield response, improved grain quality (improved seed plumpness) may result from K fertilization.

Potassium requirements for various crops are shown in Table 2.

Table 2. Potassium recommendations (0 to 6 in. soil samples*) for Saskatchewan crops.**

Soil Test	Cereals and Oilseeds	Barley and Pulses	Grass and Hay	Alfalfa and Clover
(lb. K/ac.)	lb./ac. of K_2O to apply			
0-60	120-140	140-160	120-140	140-160
61-90	90-110	110-130	90-110	110-130
91-120	80-90	90-110	80-90	90-110
121-150	56-60	80-90	60-70	80-90
151-180	15-25	50-60	50-60	60-70
181-210	10-20	10-20	30-40	50-60
211-350	0 or 15 ***	0 or 15 ***	0-30	40-50

* For 0 to 12 in. samples, multiply the 0 to 12 in. soil K level by 0.60 to convert to 0 to 6 in. samples.
** Saskatchewan Soil Fertility Committee.
*** Guideline only; responses in high potassium soils may be a result of physiological, environmental or disease effects.

This bulletin was reviewed by the Saskatchewan Soil Fertility Committee.

For more information:

Contact the Agriculture Knowledge Centre at 1-866-457-2377.